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VIDEO-ON-DEMAND SERVICE USING ATM CELLS

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(57)

A system for multimedia services uses a distribution network with broadband channels as downstream channels to customers for transmitting requested information. Transmission is in ATM. Signalling information is to be transmitted in narrow-band channels, but nevertheless in ATM. Near the customers, conversion centers are installed. Between the exchange and these conversion centers, signalling information is transmitted in conventional ATM channels. Between the conversion center and the customers, narrow-band time-division multiplex technology is used. In the narrow-band channels, ATM cells are used transparently up to the customers.

CLAIM

1. A system, particularly for multimedia services (MM), including video-on-demand service (VoD), with a center (20, Hub), a distribution network (61, ..., 64; Coax), and customer equipments (30) connected thereto, with broadband channels (61, 62) from the center to the customer equipments, and with narrow-band return channels (63, 64) from the customer equipments to the center,

c h a r a c t e r i z e d i n that each return-channel-capable customer equipment (30) includes a transmitting device (81', 82', 83', 86') by means of which a data stream consisting of ATM cells is formed from the messages to be transmitted to the center, then converted into a return channel assigned to said customer equipment, and fed into the distribution network (Coax), that the center (20, Hub) includes receiving devices (RFLT, ATM)) by means of which the data streams of the respective return channels are recovered and temporarily stored as sequences of ATM cells, and that the center includes a multiplexer (86) which combines the individual data streams into an overall ATM data stream.

2. Customer equipment (30), particularly for multimedia services (MM), including video-on-demand service (VoD), with a receiving device for selecting one of a plurality of broadband channels and for receiving a broadband data stream transmitted therein, c h a r a c t e r i z e d i n that there is provided a transmitting device (81', 82', 83', 86') by means of which a data stream consisting of ATM cells is formed from the messages to be transmitted to a center (20, Hub), then converted into a return channel assigned to the customer equipment, and fed into the distribution network (Coax).

3. A center (20, Hub), particularly for multimedia services (MM), including video-on-demand service (VoD), c h a r a c t e r i z e d i n that the center includes receiving devices (RFLT, ATM) by means of which the data streams of the respective return channels are recovered and temporarily stored as sequences of ATM cells, and that the center includes a multiplexer (86) which combines the individual data streams into an overall ATM data stream.

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ORIGINAL
COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title:

"VIDEO-ON-DEMAND SERVICE USING ATM CELLS"

The following statement is a full description of this invention, including the best method of performing it known to us:-

System, Customer Equipment, Center, and Method for Video-on-Demand Service

The present invention relates to a system particularly suited for multimedia services, including video-on-demand service, as set forth in the preamble of claim 1, to customer equipment suited therefor as set forth in the preamble of claim 2, to a center as set forth in the preamble of claim 3, and to a method for implementing such services as set forth in the preamble of claim 4.

For such services, distribution networks with broadband downstream channels to subscribers and narrow-band return channels to the center are known.

It is known to use such distribution networks as a common transmission medium for different services. To be able to easily separate the services from one another, use is frequently made of frequency channels which are completely independent of each other. The basis is frequently a television distribution network in which some frequency channels are already occupied by freely accessible television programs. In the future, more and more television programs will only be transmitted on demand ("video-on-demand"). This necessitates data reductions, so the aim is to use exclusively digital techniques. Therefore, information

is to be stored and transmitted using ATM technology (ATM = asynchronous transfer mode), i.e., in the form of ATM cells.

It is therefore necessary to also introduce the request and other signalling data coming from the customers over their return channels into an ATM network.

According to the invention, this is accomplished according to the teaching of claims 1 to 4.

The basic idea is that the customer equipment generates its messages already in the form of ATM cells and transmits the latter transparently in a return channel allocated to it alone (at least for the signalling period).

Further advantageous features of the invention are defined in the subclaims.

The invention will become more apparent from the following description of an embodiment taken in conjunction with the accompanying drawings, in which:

Fig. 1 shows the overall configuration of a system according to the invention;

Fig. 2 shows a possible frequency allocation scheme for the system according to the invention;

Fig. 3 shows the allocation of ATM cells to synchronous channels;

Fig. 4 shows a part of the system according to the invention in which the center according to the invention is illustrated in greater detail;

Fig. 5 shows a part of the center according to the invention with further details, and

Fig. 6 is a block diagram of customer equipment according to the invention.

The system of Fig. 1 comprises an ATM exchange 10, a remote center 20, several customer premises equipments 30, henceforth called "customer equipments" for short, two demand centers 40, a broadband telecommunication network 50, and two broadband optical network termination units 60.

In the ATM exchange 10, a switching network 11 and a few ATM interface modules 12, 13, and 14 are indicated.

One of the demand centers 40 is connected by a line 41 to the ATM exchange 10 at one of the ATM interface modules 12. The other of the two demand centers 40 is connected to an ATM exchange (not shown) of the broadband telecommunication network 50 by a line 41. The broadband telecommunication network 50 is connected to a further ATM interface module 12 of the ATM exchange 10 by a trunk 51.

The ATM exchange 10 is connected to the remote center 20 via several one-way ATM channels 15, which allow data to be transferred from the ATM exchange 10 to the remote center 20, and via a two-way ATM channel 16.

The remote center 20 is connected to each of the broadband optical network termination units 60 via a respective broadband link 61 and a respective narrow-band link 63. The links continue from the network termination units 60 to the customer equipment 30 as broadband links 62 and narrow-band links 64, respectively.

By "demand center" 40 is understood a facility which can be caused by remote control to transmit selected data in the broadest sense. In particular, interactive remote control within a multimedia service is envisioned wherein the first steps of the remote control relate to the selection of a video server for providing video-on-demand service, and wherein the further steps relate to the selection of a particular video film. The film selected by this remote control is subsequently transmitted to the customer by data transmission. Voice-operated remote control is also possible.

The data transmission is to be in ATM, so the request and other signalling data, i.e., the data necessary for remote control, also is to be transmitted in ATM.

Such demand centers 14 may be located at any point of the broadband telecommunication network 50. The latter need not operate in ATM throughout. In that case, interworking must be provided which permits communication with the ATM exchange 10.

The design of the ATM exchange 10, including the switching network 11 and the ATM interface modules 12, 13, and 14 contained therein, is not specific to the

invention. What may possibly give rise to a special design is the fact that the interface modules 12 carry predominantly incoming traffic and the interface modules 13 exclusively outgoing traffic.

The links between the ATM exchange 10 and the remote center 20 are deliberately referred to here by the somewhat vague term "channels". What matters is not whether optical or electrical transmission takes place or whether only one line with a plurality of paths separated in wavelength or frequency or two or more optical or electric lines are used. The same applies to the "links" between the remote center 20, the network termination unit 60, and the customer equipment 30.

In the underlying project, optical fibers are to be used in the area between the ATM exchange 10 and the network termination unit 60, while coaxial cables are to be used in the customer area, i.e., between the network termination unit 60 and the customer equipment 30. Existing broadband cable networks are to be utilized to a large extent, with television programs being transmitted in the conventional manner. Combination can take place at the remote center 20 or at the network termination units 60. For the narrow-band links 64, existing telephone subscriber lines could be used, but in the following, another possibility is described.

The customer equipment 30 can be either modem-like interface units for television sets (also called "set-top units") or PCs, or also television sets or PCs with such interface units.

Fig. 2 shows a possible frequency allocation plan for the information transmission between the network termination units 60 and the customer equipment 30. A channel arrangement with 8-MHz channels as is currently used for analog television is taken as a basis. Some of these channels can be and are to be used in this system for distributing television programs in analog form. A few other of these channels are to serve to transmit television signals in digital form. By use of redundancy-reducing techniques, e.g., according to the MPEG standard (MPEG = Motion Picture Expert Group), and suitable modulation methods, such as 64-level quadrature amplitude modulation, QAM64, approximately five or six television signals can be transmitted in one channel. This is possible both continuously for purposes of distribution and on demand from a demand center.

Information is to be transmitted not only downstream to the customers, but also upstream to the remote center for signalling or remote-control purposes. A few channels in the lower frequency range are assigned for this purpose. These can have a totally different arrangement. It is possible, for example, to assign to each customer a separate channel with a separate carrier for a 64-kb/s signal. In the underlying project, six channels are planned, of which four are active and two serve as spare channels. Each of the active channels contains a PCM30/32 2-Mb/s time-division multiplex signal (to be exact: a 2048-kb/s signal). Each of this total of 120 64-kb/s time-division multiplex channels could be permanently assigned to one customer. However, as will be explained below, particularly with reference to Fig. 3, a mode of

operation is preferred in which a channel is assigned only when needed, but then also two or more channels if necessary. Instead of frequency- or time-division multiplexing, code-division multiplexing is possible.

Since remote control preferably takes place in an interactive mode with the aid of menus, in the example, one of the downstream 8-MHz channels is reserved for control purposes. In this channel, an ATM data stream is transmitted exclusively for signalling purposes using QAM64.

This frequency division has the advantage of being easy to adapt to different conditions. Depending on the existing infrastructure and the organizational division of services among different operators, but also on, for example, customer density, which, in turn, influences the distances, and on the availibility of technology and equipment, upstream and downstream directions can use common or separate transmission media, or further services, such as distribution services and telephony, can be incorporated or not.

Fig. 3 illustrates schematically how the upstream direction of the signalling operates. The first line of Fig. 3 shows an ATM data stream consisting of successive ATM cells. Each ATM cell consists of a header, shown here as a black block, and an information field, which carries a particular pattern. Cells whose information fields carry the same pattern belong to the same data stream. Cells without a pattern are empty cells. Their headers identify them as empty cells, and their information fields carry no information.

One of the cells is designated by an "M" to indicate that it is a meta-signalling cell. ITU-T Recommendation Q.2120 recommends a protocol for signalling in ATM, which is used here as a basis. It was published by the ITU in February 1994 under number COM 11-R 50-E. A meta-signalling channel is made available as a call channel over which individual signalling channels, so-called signalling virtual channels (SVC), are allocated.

The ATM data stream shown in the first line of Fig. 3 is, at least in the customer area, a fictitious data stream. Each of the customer equipments 30 conditions its signalling information in the form of such ATM cells. In the header, among other things, the signalling virtual channel allocated by meta-signalling is identified. To transmit information to the network termination unit 60 over the narrow-band link 64, the individual customer equipments do not successively insert their cells into the data stream, but this information is transmitted using synchronous time-division multiplexing, as illustrated in the second line of Fig. 3.

This second line of Fig. 3 shows a single frame of a normal PCM30/32 data stream. As usual, eight bits form a time slot. Time slots 0 and 15 are not free for data transmission. Like the headers in the first line, these time slots are shown as black blocks, but they have nothing to do with those headers. Time slot 1 is reserved for the above-mentioned meta-signalling channel, and time slots 2 to 14 and 16 to 31 are reserved for signalling virtual channels. It can be seen that the different hatchings of the first line

also occur in the different time slots of the second line. Hatchings which occur frequently in the cells of the first line also occur frequently in the time slots of the second line.

In the course of the assignment of the individual signalling channels, the SVCs, the time slots are assigned. Each SVC is assigned at least one time slot. Within the respective assigned time slots, complete ATM cell streams with exclusively complete cells, including the headers, are transmitted. Thus, each customer equipment 30, as long as time slots are assigned to it, continuously transmits an ATM cell stream with empty cells possibly contained therein. If two or more time slots are assigned to the same SVC, they will preferably be used one after the other. In the example shown, time slots 3, 11, 20, and 31 are hatched alike, and thus belong to the same data stream and consequently carry successive octets of this data stream. An essential aspect of the invention is not conveyed by this representation, namely the fact that the headers of the ATM cells are also incorporated into the time slots.

To access the meta-signalling channels in time slot 1, any suitable access method can be used. The method currently intended to be used is the ALOHA method, in which each customer equipment wishing to signal transmits a corresponding wish in an uncoordinated manner. When a customer equipment is transmitting alone, it is understood by the opposite end at the remote center and receives a reply. When two customer equipments are transmitting simultaneously, they interfere with one another, are not understood, and

receive no reply. Both will then make another attempt with random delays. In the polling method, which can also be used, the customer equipments are interrogated one after the other. If the customer equipments are arranged in a ring, the token-ring method can be used. A token is circulated and is captured by the customer equipment wishing to seize the meta-signalling channel. The token is then passed on. If a low signalling volume is to be expected, one of these methods could also be used for the signalling itself, so that only one channel would be needed for all customers together.

The frame shown in the second line of Fig. 3, too, is more or less fictitious, depending on the configuration of the lines forming the narrow-band link 64. By taking suitable synchronization measures, which are known per se, it must be ensured that at the network termination unit the signals coming from the individual customer equipments are inserted into the frame in correct time sequence.

The overall system, with the exception of the customer equipment, will now be described in more detail with the aid of Fig. 4. The figure shows the ATM exchange 10, the remote center 20, one of the demand centers 40, and one of the broadband optical network termination units 60 as well as a distribution-service center 70, a narrow-band exchange 17, and a broadband optical network termination unit of another type 65. The remote center 20 contains an ATM switching network 21, a narrow-band multiplexer 22, and several optical line termination units 23.

The distribution-service center 70 has several inputs for video signals which are converted, partly in analog form via modulators MOD, partly in digital form by

means of quadrature amplitude modulators QAM, into different frequency bands, then combined via a summer and, after being converted from electrical to optical form, distributed. The distribution services are designated here as CATV (cable TV), DVB (digital video broadcasting), and nVoD (near-video-on-demand). In the near-video-on-demand service, selected programs are transmitted several times with graduated starting times. The distribution is indicated here by splitters. One of the outgoing optical fibers of the splitter goes to the remote center ("hub") 20. The signal is first amplified in a fiber-optic amplifier FOA, then fed through a further splitter into the individual line termination units (OLT1...OLT16) 23. There it is amplified again (FOA), combined in a summer with other optical signals to be transmitted, and distributed via a wavelength-selective directional gate and a further splitter to the connected broadband optical network termination units 60 and 65 and from there via coaxial cables Coax. To this end, the signal is converted from optical to electrical form and electrically adapted via an interface; in the case of the network termination unit 65, it is also filtered.

Via the ATM exchange 10, connections are established from the demand center 40 (VoD Server) and the broadband telecommunication network 50 to the remote switching center 20. Apart from the video-on-demand and other multimedia services (VoD, MM) being considered here, these are arbitrary other ATM connections. In the remote center 20 the ATM switching network 21 is provided, by way of example, for establishing connections between the ATM exchange and the individual line termination units 20. Connections which serve to

exchange signalling information with, e.g., the demand center 40 pass through an ATM part ATM and a quadrature amplitude modulator QAM to a summer, where they are combined with the broadband signals (VoD, MM) received directly via quadrature amplitude modulators QAM. After being converted from electrical to optical form, they are combined with the distribution-service signals in the aforementioned summer and distributed together with these signals.

With the two different network termination units 60 and 65, different possibilities of transmitting broadband connections 61 and 62 and narrow-band connections 63 and 64 are shown. Between the remote center 20 and the network termination unit 60 or 65, the connections are transmitted in this example over separate channels, but on common lines. In the network termination unit 60 they are not separated, so they are transmitted to the customer equipment on a common line (coaxial cable). In the network termination unit 65, however, separation is provided such that the broadband connections, together with the distribution-service signals, are routed to the coaxial cables through the filters mentioned in connection with the distribution-service signals, while the narrow-band connections are coupled to separate lines MM through a radio-frequency network termination unit RFNT and a multimedia interface MM-Intf. Via this network termination unit RFNT and a telephone interface POTS Intf., signals for a conventional telephone POTS (POTS = Plain Old Telephone Service) are coupled out.

The narrow-band exchange 17 is connected, on the one hand, to a narrow-band telecommunication network (the "normal" telephone network) and, on the other hand, to

the narrow-band multiplexer 22 in the remote center 20. Whether the connection is designed for analog (plain old) telephone service POTS or for digital telephone service ISDN or permits both services is left open here. The question as to which of the possible techniques is used for the transmission of POTS will not be considered here, either. The multiplexer 22 establishes the connection with a respective narrow-band part NB in each of the line termination units 23. Each narrow-band part NB is connected by a bidirectional link with a radio-frequency line termination unit RFLT. The radio-frequency line termination unit RFLT transmits on one of the channels described with reference to Fig. 2. This channel is combined with the quadrature-amplitude-modulated broadband signals and the signalling messages from the ATM part ATM in the summer mentioned above. The signal of the opposite direction is coupled out in the wavelength-selective directional gate and, after being converted from optical to electrical form, fed to the radio-frequency line termination unit RFLT, from where it passes through the narrow-band part NB and the multiplexer 22 to the narrow-band exchange 17.

The signalling messages from a customer equipment to the demand center 40 travel the same path up to the radio-frequency line termination unit RFLT, from where they go through the ATM part ATM, the switching network 21, and the ATM exchange 10.

Signalling messages between any of the customer equipments and the remote center 20 are handled at the latter in the ATM part ATM. Such signalling serves mainly to assign time slots.

Transmission of the broadband connections 61 and the narrow-band connections 63 on separate (optical or electric) cables is also possible in the area between remote center 20 and the broadband network termination units 60 and 65. This is advantageous if signalling messages and other narrow-band signals travelling to the customer are converted to ATM and moved onto the broadband links. Broadband and narrow-band links are then only one-way links. This results in a relatively simple technology.

Further details of the remote center 20 will now be described with reference to Fig. 5. Fig. 5 shows the ATM switching network 21 and part of one of the optical line termination units 23 with the radio-frequency line termination unit RFLT, the ATM part ATM, and the quadrature-amplitude modulator QAM succeeding the ATM part ATM.

The radio-frequency line termination unit RFLT has one receiver unit 81, comprising a channel filter and a demodulator, and one adapter 82 for each of the four channels carrying one time-division multiplex data stream each. The adapter 82 serves, inter alia, to produce synchronization.

The ATM part ATM contains a format converter unit 83, a decryption unit 84, a buffer 85, an ATM multiplexer 86, a control unit 87 with a signalling monitoring circuit 88, a signalling processing circuit 89, a signalling circuit 90, and a time-slot assignment circuit 91, and an encryption unit 92.

The format converter unit 83 converts the four time-division-multiplexed data streams into 120 data streams with complete ATM cells. These data streams are decrypted in the decryption unit 84 and so buffered in the buffer 85 as to be combined into a normal ATM data stream in the ATM multiplexer 86. ATM cells which, according to their headers, are not to be passed on to the ATM exchange are not inserted into the data stream by the ATM multiplexer. Free capacities are filled up with empty cells.

The control unit 87 has the function of processing the return channels formed according to the invention. This is done particularly by the signalling processing circuit 89. To this end, the latter is notified of all requests for capacity from customer equipment via the signalling monitoring circuit 88, and of all capacity assignments coming from or via the ATM exchange by the signalling circuit 90. The processing circuit 89 thus manages the four times 30 available time slots. Assignments or withdrawals of time slots are signalled, on the one hand, to the respective customer equipment via the signalling circuit 90 in the form of ATM cells and, on the other hand, to the format converter unit 83 via the time-slot assignment circuit 91.

With the aid of Fig. 6, a customer equipment will be described as far as signalling is concerned. The path of the useful information is not shown here. A multimedia device is assumed here which receives useful information from several remote stations and, therefore, has control channels to several remote stations. This device may also be an interface unit which processes the signalling information for several

independent terminals. If the device is a simple terminal with only one remote station, the parallel processing paths in the lower part are not necessary.

Fig. 6 is practically the mirror image of Fig. 5; like reference characters have been used to designate corresponding parts. Fig. 6 shows a demodulator QAM' for quadrature amplitude modulation, a radio-frequency network termination unit RFNT' and an ATM part ATM'. The input of the demodulator QAM' and the output of the network termination unit RFNT' are connected to the coaxial cable Coax.

The network termination unit RFNT' contains an adaptor 82' and a transmitter unit 81' with a modulator and a frequency converter.

The ATM part ATM' contains an interface unit 93, an ATM demultiplexer 86', a decryption unit 84', a format converter unit 83', a control unit 87' with a signalling monitoring circuit 88', a signalling computation circuit 89', a further signalling monitoring circuit 90', and a time-slot and channel assignment circuit 91', and a decryption unit 92'.

Unlike the signalling processing circuit 89 in the remote center, the signalling computation circuit 89' does not give instructions, but only executes instructions. Therefore, it only monitors both directions without inserting signals itself. It is assumed here, however, that at the customer end only a single time-division-multiplexed data stream is available, so that the frequency converter in the transmitter unit 81' has to be tuned thereto.

Abstract

System, Customer Equipment, Center, and Method for Video-on-Demand Service

A system for multimedia services uses a distribution network with broadband channels as downstream channels to customers for transmitting requested information. Transmission is in ATM. Signalling information is to be transmitted in narrow-band channels, but nevertheless in ATM. Near the customers, conversion centers are installed. Between the exchange and these conversion centers, signalling information is transmitted in conventional ATM channels. Between the conversion center and the customers, narrow-band time-division multiplex technology is used. In the narrow-band channels, ATM cells are used transparently up to the customers.

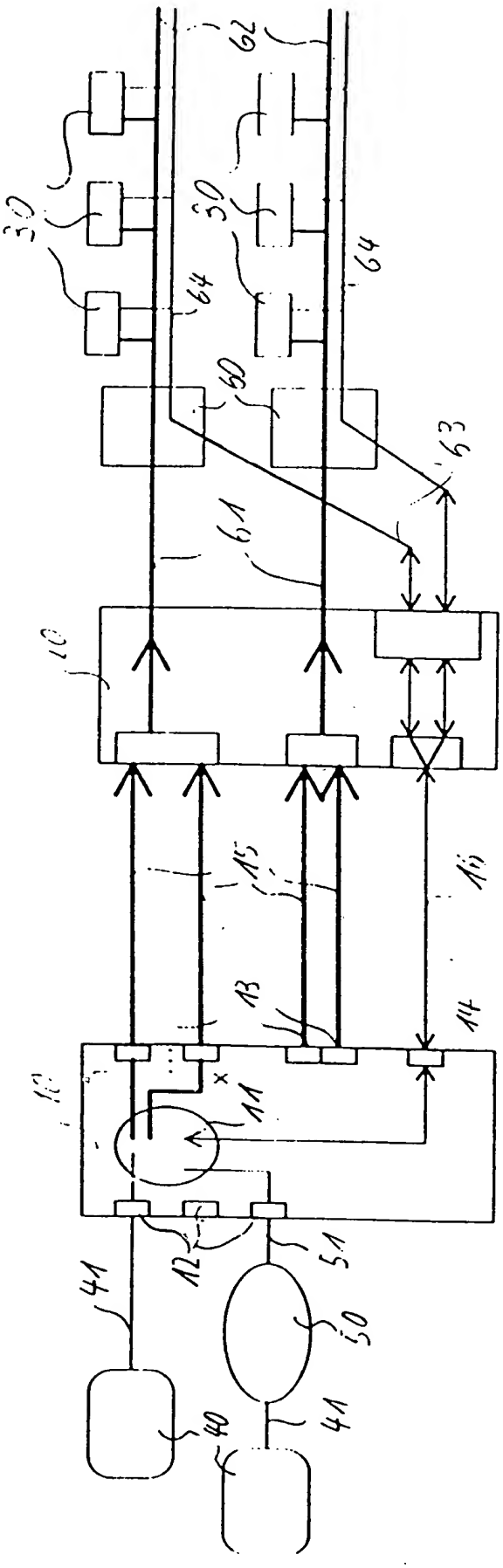

Fig. 1

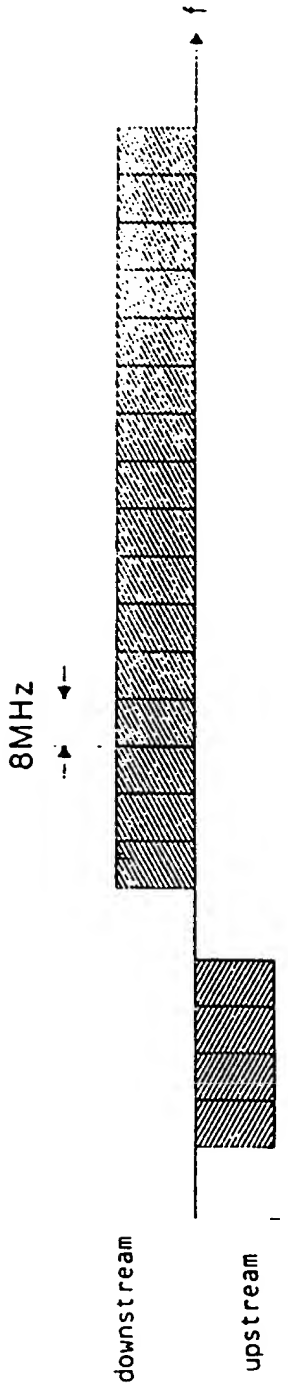

Fig. 2

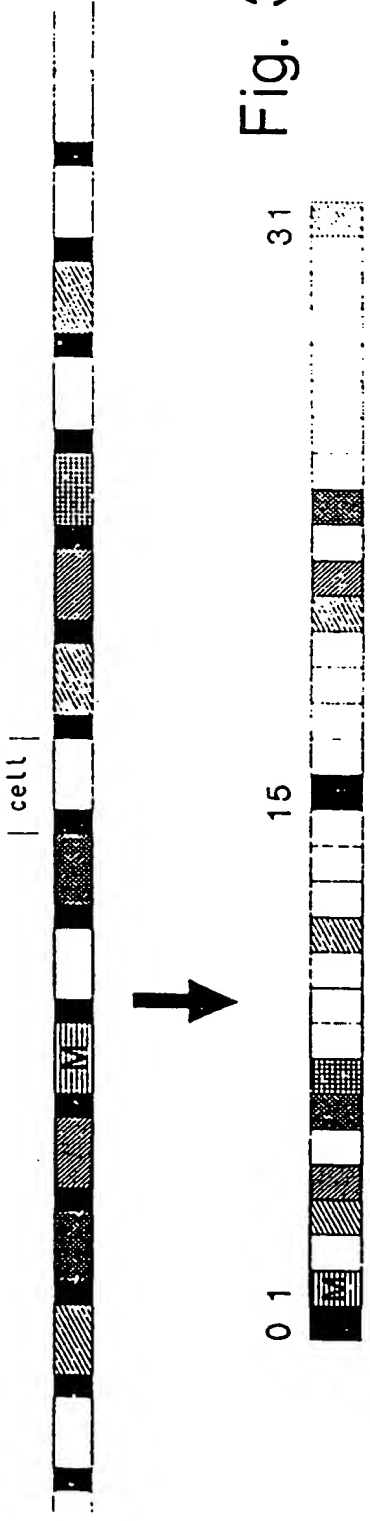

Fig. 3

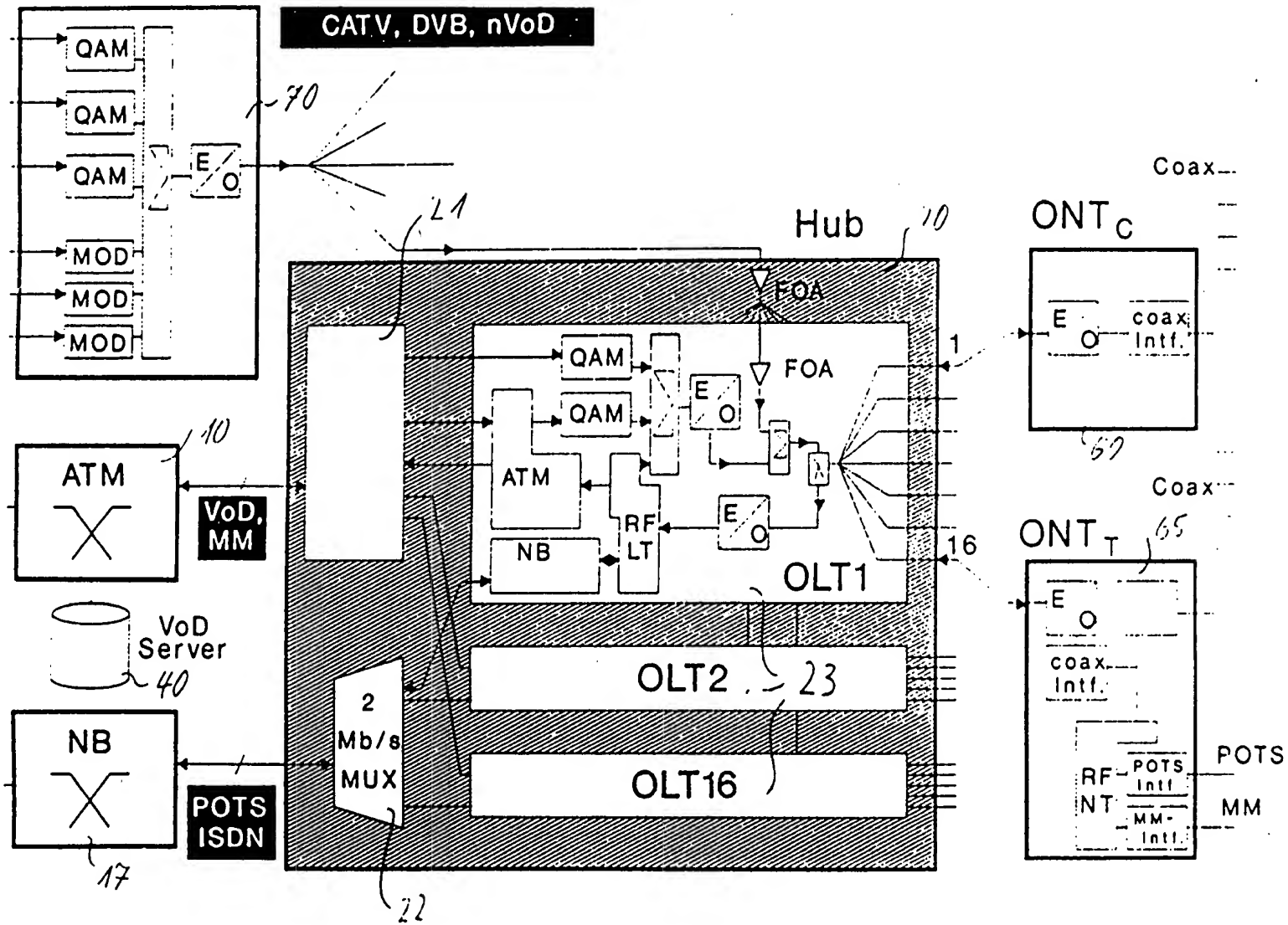

Fig. 4

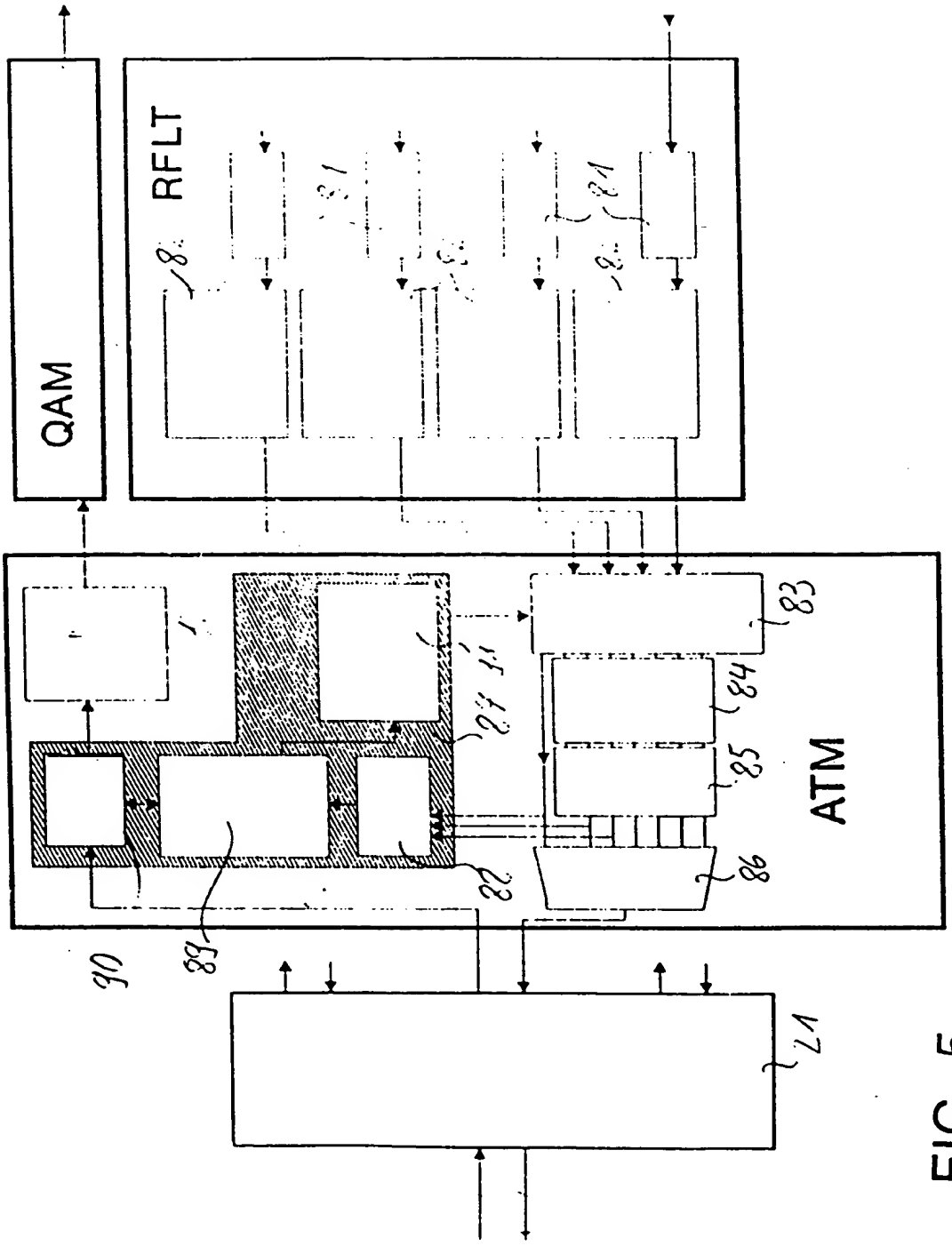

FIG. 5

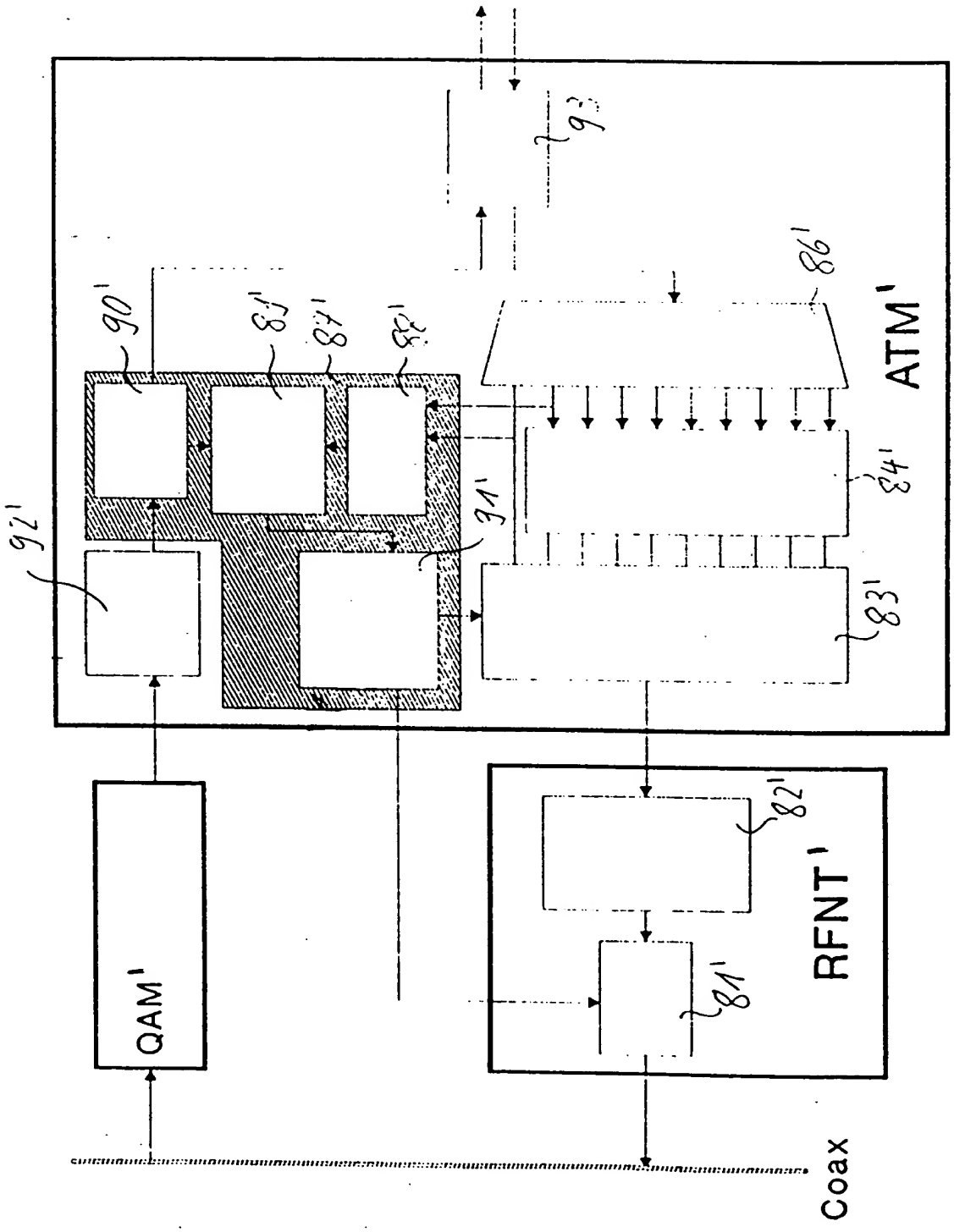

Fig. 6

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